Instrumentation engineering (INEN) program, "Instrumentation engineering" department

Course Unit Title	**Industrial Robots**
Course Unit Code	VTES-B07
Type of Course Unit	Elective
Level of Course Unit	4th year INEN program
National Credits	6
Number of ECTS Credits Allocated	6
Theoretical (hour/week)	2
Practice (hour/week)	1
Laboratory (hour/week)	2
Year of Study	4
Semester when the course unit is delivered	7
Course Coordinator	Yusubov Elvin
Name of Lecturer (s)	Yusubov Elvin
Name of Assistant (s)	-
Mode of Delivery	Face to Face
Language of Instruction	English
Prerequisites	-
Recommended Optional Programme Components	-

Course description:

This course provides a comprehensive introduction to the field of industrial robotics, focusing on the role of robots in modern manufacturing and industrial settings. Students will explore the key components of industrial robots, including sensors, actuators, controllers, and programming languages. The course covers various types of robots, from traditional robotic arms to collaborative robots (cobots), and their applications across industries such as automotive, aerospace, and electronics. Key topics include robot integration, safety considerations, robotic vision systems, and artificial intelligence. Through labs and case studies, students will gain practical insights into the design, operation, and programming of industrial robots, preparing them for careers in advanced manufacturing and automation.

Objectives of the Course:

The purpose of this course is to equip students with a foundational understanding of industrial robotics and its critical role in modern manufacturing and automation. By exploring the technical, practical, and theoretical aspects of industrial robots, students will develop the knowledge and skills necessary to design, operate, and program robotic systems in industrial settings. The course aims to foster problem-solving abilities, promote innovation in automation, and prepare students for careers in industries where robotics plays a pivotal role, such as automotive, electronics, and logistics. Additionally, the course seeks to inspire students to embrace emerging technologies like AI and IoT to optimize industrial processes and contribute to the future of smart manufacturing..

Learning Outcomes

At the end of the course the student will be able to		Assessment
1.	Understand the differences between industrial robots.	1,3
2.	Understand the differences between robotics sensors as well as Robotic end effectors	1,2,3
3.	Identifiy applications of industrial robots	2,3
4.	Learn programing fundamentals of industrial robotics	2,3
5.	Explain forward kinematics of industrial robots	1,3
6.	Explain inverse kinematics of industrial robots	2,3
7.	Explain control methods of industrial robots	1,3
8.	Explain stability analysis of industrial robots	2,3

Assessment Methods: 1. Final Exam, 2. Presentation, 3. Midterm exam

Course's Contribution to Program

		CL
1	Ability to develop as a specialist in the field of fundamental scINENces and apply basic knowledge.	4
2	Ability to analyze and model functional and structural schemes of various purpose devices and systems.	3
3	Ability to use modern methods and tools, creation, selection, and application of engineering and information technology tools and modern devices and equipment.	4
4	The ability to use the strategy of team cooperation in the exchange of information, knowledge, and experINENce to achieve the set goal.	5
5	As a result of training, the ability to use engineering knowledge, mathematical models, and basic concepts of physics and chemistry in production and technological processes, automation, measurement, and control systems.	4
6	The ability to use modern software to process technical documents of devices, design their structures, and algorithmize processes.	4
7	The ability to apply artificial intelligence to improve the quality characteristics of measurement and control systems.	1
8	The ability to process information acquisition, processing, and transmission processes based on schematic and programmable logical integrated circuits.	3
9	Ability to use knowledge to improve quality indicators and environmental safety of production processes.	4
10	Self-development ability to apply theoretical and experimental knowledge in solving modern engineering problems.	4

CL: Contribution Level (1: Very Low, 2: Low, 3: Moderate, 4: High, 5: Very High)

Course Contents

Week	Chapter	Topics	Exam
1	[1], ch.13; [2], ch.1; [3], ch.1	**LECTURE**: Fundamentals of Industrial Robotics **SEMINAR**: Quiz on fundamentals of Industrial Robotics	
2	[1], ch.14; [2], ch.2; [3], ch.10	**LECTURE**: Robotic Sensors **LAB**- Introduction to industrial robotic simulators **SEMINAR**: Quiz on robotic rensors	
3	[1], ch.15	**LECTURE**: Robotic end effectors **SEMINAR**: Quiz on Robotic end effectors	
4	[1], ch.16	**LECTURE**: Robot Programming	
5	[1], ch.17	**LECTURE**: Applications of industrial robots	
6	[1], ch.18	**LECTURE**: Robots using real time embedded systems **LAB**- Experimenting the tools Embedded C/C++ programming languages for the industial robotics **SEMINAR**: Quiz on the tools Embedded C/C++ programming languages for the industial robotics	
7	[3], ch.9	**LECTURE**: Types of motor and actuators for industrial robots	Midterm
8	[2], ch.16, p.1	**LECTURE**: Forward kinematics for industrial robots **LAB**- Performing Forward Kinematics in C++ for industrial robots **SEMINAR**: Calculations on Forward Kinematics	
9	[2], ch.16, p.2	**LECTURE**: Inverse kinematics for industrial robots **LAB**- Performing Inverse Kinematics in C++ for industrial robots **SEMINAR**: Calculations on Inverse Kinematics	
10	[2], ch.6; [3], ch.8, p.1,10,17; [4], ch.4, p.3	**LECTURE**: Control methods of the industrial robots **LAB**- Development of PID controllers of industrial robots **SEMINAR**: Calculating PID controller gains of industrial robots	
11	[5]	**LECTURE**: Adaptive control systems for industrial robots	

12	[4], ch.3, p.1,4	**LECTURE**: Time and Frequency Domain Analysis of robotic controllers	
13	[3], ch.8, p.11; [4], ch.3,	**LECTURE**: Stability of robotic controllers using Pole-Zeros	
14	[3], ch.8, p.19; [4], ch.6, p.5	**LECTURE**: Stability of robotic controllers using Bode Plots **LAB**- Performing stability analysis of industrial robots using Pole-Zero and Bode Plots **SEMINAR**: Drawing Bode-Plots of robotic controllers	
15	[4], ch.6, p.3	**LECTURE**: Stability of robotic controllers using Nyquist Plots **LAB**- Performing stability analysis of industrial robots using Nyquist Plots	
16			Final exam

Recommended Sources

TEXTBOOK(S)

1. A.K. Gupta (Author), S.K. Arora (Author), Jean Riescher Westcott (Author), "Industrial Automation and Robotic", by MERCURY LEARNING AND INFORMATION LLC, 2017, USA
2. Mordechai Ben-Ari, Francesco Mondada, 'Elements of Robotics', Springer Cham, 10 November 2017 https://doi.org/10.1007/978-3-319-62533-1
3. Saeed B. Niku, 'Introduction to Robotics Analysis, Control, Applications', Third Edition, WILEY, California Polytechnic State University, California, USA, 2020
4. Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, "Feedback Control of Dynamic Systems", Eighth Edition, Pearson Education Limited, 2020
5. Marko Švacoa, Bojan Šekoranjaa, Bojan Jerbi, "Industrial robotic system with adaptive control", Elsevier, 2012 https://doi.org/10.1016/j.procs.2012.09.048

Additional information will be distributed either electronically or delivered in printed forms.

Assessment

Attendance	0%	Less than 75% class attendance results in NA grade
Presentation	10%	
Lab	10%	
Quiz	10%	
Midterm Exam	20%	Written Exam
Final Exam	50%	Written Exam
Total	100%	

Assessment Criteria

Final grades are determined according to the Academic Regulations of Azerbaijan State Oil and İndustry University for undergraduate studies

Course Policies

- Attendance of the course is mandatory.
- Material presented in the lecture as well as assigned readings will be included in testing.
- Late assignments will not be accepted unless an agreement is reached with the lecturer.
- Cheating and plagiarism will not be tolerated.
- Cheating will be penalized according to the Azerbaijan State Oil and Industrial University General Student Discipline Regulations

ECTS allocated based on Student Workload

Activities	Number	Duration (hour)	Total Workload (hour)
Course duration in class	15	4	60
Presentation	1	8	8
Self-study	15	3	45
Tutorials	15	3	45
Midterm Examination	1	3	3
Preparation for midterm exam	1	8	8
Final Examination	1	3	3

Preparation for final exam	1	18	18
Total Workload			190
Total Workload/30(h)			6.3
ECTS Credit of the Course			6